

Description and biology of a new species of *Meteorus* Haliday (Hymenoptera: Braconidae, Meteorinae) from Costa Rica, parasitizing larvae of *Papilio* and *Parides* (Lepidoptera: Papilionidae)

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Abstract.—*Meteorus papiliovorus* Zitani, a new species from Costa Rica, is described and illustrated. This species is a gregarious koinobiont endoparasitoid of papilionid larvae including *Papilio anchisiades idaeus* Fabricius on *Citrus* and *Parides sesostris zestos* (Gray) on *Aristolochia tonduzii*. Notes on its biology, distribution, and cocoon-forming behavior are given. This is the first record of any New World *Meteorus* attacking Papilionidae, and the first record of *Meteorus* utilizing "nasty" hosts that are believed to contain toxic secondary chemicals.

INTRODUCTION

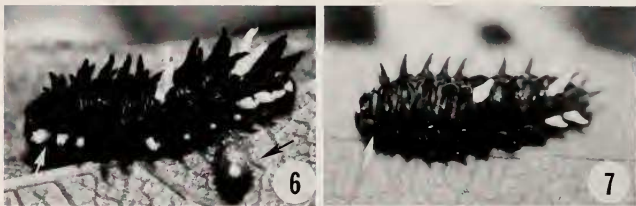
During March of 1993 one of us (SRS) visited the La Selva Research Station in Costa Rica, where Ronald Vargas (a parataxonomist working on the ALAS project—Arthropods of La Selva) called to my attention a parasitoid wasp that he had recently reared from *Papilio anchisiades idaeus* Fabricius on *Citrus* (Rutaceae). This was immediately recognized to be a new species of *Meteorus* Haliday, of particular interest for several reasons: it provides the first New World record of *Meteorus* attacking Papilionidae, it is a gregarious species with remarkably short cocoon-suspending threads (Figs. 1–2, 4), and it is potentially of interest as a biocontrol agent for *Citrus*-feeding papilionids. We returned to the collecting site and made an even more remarkable observation—the *Citrus* tree had been virtually defoliated by leaf cutter ants, except for one leaf with another cluster of *Meteorus* cocoons (Figs. 1–2). This observation, combined with the short cocoon threads, raises the exciting possibility that either this new species, or its host, has evolved some defense mechanism to deter leaf cutter or other ants—a discovery that

might be of considerable economic benefit to INBio or other bioprospecting ventures. Subsequent studies of the INBio collection indicated that this species is widely distributed in Costa Rica. In 1995 one of us (DHJ) discovered that *Parides* on *Aristolochia* (Aristolochiaceae) is another host of this parasitoid. DHJ had also reared this wasp from *P. anchisiades* in the dry forest of the Area de Conservacion Guanacaste (ACG) in northwestern Costa Rica. During June of 1996 NMZ reared this species from *Parides sesostris zestos* (Gray) on *Aristolochia tonduzii* (Fig. 6) at the Pitilla Biological Station, ACG. The purpose of this paper is to provide a scientific name for this new *Meteorus* species, to facilitate ongoing studies of its biology, and as a contribution to the ALAS project and the biodiversity inventory of the ACG.

Meteorus Haliday is the most prominent genus of the braconid subfamily Meteorinae (sensu S. Shaw 1985, 1994; Maetô 1990; M. Shaw and Huddleston 1991), sister-group of the Euphorinae (sensu stricto), which is a moderately large subfamily comprising at least 174 species worldwide (S. Shaw 1988). Meteorines are sometimes



Figs. 1-5. 1. Cocoons of *Meteorus papiliovorus* on leaf of *Citrus* tree at La Selva. Note extensive defoliation of adjacent foliage. 2. Close-up of gregarious cocoons of *Meteorus papiliovorus* on leaf of *Citrus* tree at La Selva. 3. Ultimate instar of *Parides sesostris zestos*, larval form A, on *Aristolochia tonduzii* at Pitilla. 4. Close-up of single cocoon of *Meteorus papiliovorus*. 5. Cocoons of *Meteorus papiliovorus* at Pitilla. Note one exceptionally long cocoon thread.



Figs. 6-7. 6. Penultimate instar of *Parides sesostris zestos*, larval form A, with *Meteorus papiliovorus* cocoon. 7. Penultimate instar of *Parides sesostris zestos* (?), larval form B.

classified as a tribe within the Euphorinae (e.g. Marsh 1979; Gauld and Bolton 1988; Quicke and van Achterberg 1990). *Meteorus* has been seldom studied in the New World tropics, and only a few works are directly applicable to the Costa Rican fauna (Muesebeck 1923, 1956; S. Shaw 1995). One of us (NMZ) is currently working on a revision of Costa Rican *Meteorus*.

Meteorines are solitary or gregarious koinobiont endoparasitoids of larval Coleoptera or Lepidoptera, and many *Meteorus* species have broad host ranges (Achterberg 1979; West and Miller 1989; Maetô 1990). The vast majority of meteorines are solitary parasitoids attacking exophytic (exposed-feeding) lepidopteran larvae, and many are nocturnally active. Others utilize hosts that are only weakly concealed (e.g. in leaf rolls or under webbing). The most frequently utilized hosts are Noctuidae, Geometridae, and Tortricidae, but many other lepidopterans including Hepialidae, Zygaenidae, Tineidae, Gelechiidae, Pyralidae, Papilionidae, Lycaenidae, Nymphalidae, Lasiocampidae, Thaumetopoeidae, and Arctiidae have been recorded as hosts (Muesebeck 1923; Huddleston 1980; Maetô 1989, 1990). The solitary parasitoids of arboreal Lepidoptera typically emerge from the host larva and pupate away from the host remains in a pendant cocoon that is often suspended by a long slender thread (Gauld and Bolton 1988), and it is from this character-

istic cocoon that the genus *Meteorus* gained its name. Cocoon threads are usually about 1-8 cm long, with some as long as 20 cm (M. Shaw and Huddleston 1991). It has been postulated that this suspended cocoon is an anti-predator defensive adaptation. The cocoons are also commonly subject to hyperparasitism. The gregarious *Meteorus* species usually form their cocoons together in a loose, irregular heap (Huddleston 1980), although the terminal threads may still be present, but intertwined (S. Shaw 1985). A few highly specialized gregarious species from Africa and Sri Lanka form a very organized spherical cocoon mass, with all the exit holes facing outwards (Nixon 1943; Huddleston 1983). Those species attacking Coleoptera larvae typically utilize hosts concealed in wood, bark or fungus, especially Cerambycidae, Tenebrionidae, Scolytidae, Biphylidae, Melandryidae, and Cisidae (Huddleston 1980). As far as known, the *Meteorus* species attacking coleopterous larvae form stalkless cocoons within the beetle gallery (DeLeon 1933; Mason 1973), and these are regarded as relatively primitive (Mason 1973; Maetô 1990).

The only previous record of *Meteorus* attacking Papilionidae is a record of the Old World species *Meteorus pulchricornis* (Wesmael) using a papilionid (Maetô 1990), and this may be only an opportunistic association, since records indicate that *pulchricornis* is a generalist species that oth-

erwise attacks a variety of hosts including noctuids, arctiids, geometrids, lymantriids, lasiocampids, nymphalids, and lycaenids. This paper provides the first record of any New World *Meteorus* attacking Papilionidae, and the first record of *Meteorus* utilizing "nasty" hosts that are assumed to contain toxic secondary chemicals.

METHODS

Species covered in this paper can be identified as members of the subfamily Meteorinae using the keys of S. Shaw (1995) or M. Shaw and Huddleston (1991). Our definition of *Meteorus* follows that of Huddleston (1980, 1983), S. Shaw (1985), and Maetô (1989, 1990). Specimens can be determined as *Meteorus* using the key of Marsh *et al.* (1987).

Terminology mostly follows that used for *Meteorus* by Huddleston (1980, 1983) and Maetô (1989, 1990). Microsculpture terminology follows that of Harris (1979). Wing venation terminology agrees with the system being adopted for the *Identification Manual for New World Genera of the Family Braconidae* (in preparation), and agrees closely with that of Goulet and Huber (1993). To avoid confusion, a labelled diagram is provided here (Fig. 10). Because of varied body metasomal positions in many specimens, body length was taken as the combined measure of the length from head to end of propodeum, added to the length from base of the first tergite to end of metasoma (not including ovipositor). Abbreviations for museums can be found in the Acknowledgments section. Authorship of this new species is attributed to the senior author (NMZ).

Meteorus papiliovorus Zitani,
new species
(Figs. 8–10)

Holotype female.—**Body color:** (Fig. 8) body yellow except head orange dorsally, antenna black; mesonotum brown anteriorly and laterally, orange dorso-medially;

prothoracic leg with femur brown apically, tibia brown basally and apically, apical tarsomere and pretarsus dark brown; mesothoracic leg with femur brown apically, tibia brown apically, apical tarsomere and pretarsus dark brown; metathoracic leg with coxa brown apically, trochantellus brown, femur dark brown apically, tibia dark brown basally and apically, tarsus dark brown; metasoma dark brownish black dorsally except first tergite yellow basally, third tergite with lateral orange spots; laterotergites orange; wings deeply infused with dark blackish pigment. **Body length:** 4.6 mm. **Head:** (Fig. 9) 1.2× wider than high in anterior view, head height 1.7× eye height in anterior view; antenna filiform with 26 flagellomeres; flagellar length/width ratios as follows: F1 = 3.2, F2 = 3.0, F3 = 3.0, F22 = 2.5, F23 = 2.8, F24 = 2.6, F25 = 2.2, F26 2.8× longer than wide basally, pointed apically; eye not large but protuberant; eyes not strongly convergent, nearly parallel in anterior view; maximum face width 1.2× minimum face width; minimum face width 1.2× clypeus width; ocelli not conspicuously large, ocellar-ocular distance 1.9× diameter of lateral ocellus; malar space length 2.4× mandible width basally; face protuberant medially, laterally depressed above anterior tentorial pits, polished, punctate; clypeus polished, punctate; mandible strongly twisted. **Mesosoma:** notauli areolate; mesonotum polished, punctate dorsally; scutellar furrow 2-foveate; mesopleuron polished, punctate; sternaulus rugose; propodeum areolate-rugose, median depression present. **Legs:** hind coxa polished, punctate; tarsal claws simple. **Wings:** (Fig. 10) forewing length 3.9 mm; vein m-cu antefurcal; vein r 2× length of 3RSa; second submarginal cell strongly narrowed anteriorly. **Metasoma:** polished, smooth and shining; first tergite dorsally longitudinally costate, dorsopes absent, ventral borders joined along basal ½ of segment; ovipositor 1.6× longer than first tergite.



Fig. 8. Lateral habitus of *Meteorus papiliovorus*.

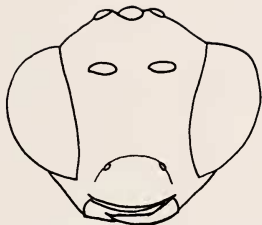


Fig. 9. Anterior view of head of *Meteorus papiliovorus* showing eye shape.

Variation, paratype females.—26 to 28 flagellomeres; fore wing length 3.4 to 3.9 mm; vein m-cu interstitial; fore wing veins r and 3RSa about equal in length; ovipositor 1.6 to 1.9× longer than tergite 1; brown areas vary from light brown to dark brownish-black except metasoma; mesonotum yellow; propodeum with brown spots dorsally; hind coxa almost completely dark brown; tergite 1 completely yellow; tergite 3 without lateral orange spots; body length 4.1 to 4.6 mm.

Variation, paratype males.—As in females except 26–32 flagellomeres; body length 3.6 to 4.3 mm; mesonotum orange; fore and mid legs orange except apical tarsomere and pretarsus brown; hind coxa, trochantellus, and femur yellow.

Description of cocoon.—(Figs. 1–2, 4–5)

length 4.6 to 5.7mm, 1.9 to 2.2mm wide medially; suspended dorsally from a short thread usually 1.0 to 1.7mm long, exceptionally 4.5–10cm long (Fig. 5); terminating ventrally with a rounded nipple-like projection (Figs. 4–5); silk color mostly glossy brown, lighter at ventral apex; emergence hole neatly cut as a $\frac{7}{8}$ th semi-circle, apex remaining attached as a cap.

Material Examined.—Holotype female with cocoon: **COSTA RICA: Heredia Province:** Est. Biol. La Selva, 50–150m, 10° 26'N, 84° 01'W, March 1993, R. Vargas, INBio-OET, INBIOCR1001219752, reared from *Papilio anchisiades idaeus* larva on *Citrus*. Deposited in INBio. Paratypes: **COSTA RICA: Alajuela Province:** 4 females, 5 males, M-12, Naranjo, October 17, 1990, col. Marvia R., INBIOCR1001008313–321. **Guanacaste Province:** 1 female, 1 male, ACG, Santa Rosa, Bosque Humedo, each reared from *Papilio anchisiades* on *Xanthoxylum setulosum*, D.H. Janzen voucher specimen #90-SRNP-2177; 2 females, ACG, Est. Pitilla, reared from *Parides sesotris zestos* larva, wasps eclosed 28 June 1995, D.H. Janzen voucher specimen #95-SRNP-4760; 2 females with cocoons, ACG, Est. Pitilla, 600m, reared from *Parides sesotris zestos* larva on *Aristolochia tonduzii*, larvae coll. 14 June 1996, wasps em. 8–9 July 1996, #96-NZ-25, N. Zitani; 4 females with cocoons, ACG, Est. Pitilla, 600m, reared from *Parides sp.* larva on *Aristolochia ton-*

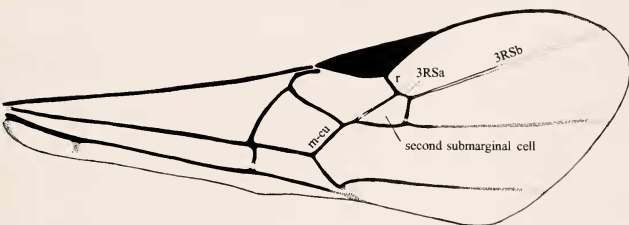


Fig. 10. Forewing venation of *Meteorus papiliovorus*.

duzii, larva coll. 23 June 1996, wasps em. 4–6 July 1996, #96-NZ-42, N. Zitani; 4 females with cocoons, ACG, Est. Pitilla, 600m, reared from *Parides* sp. larva on unidentified host plant, larva coll. 26 June 1996, wasps em. 5–7 July 1996, #96-NZ-44, N. Zitani. **Heredia Province:** 4 females with cocoons, same data as holotype except INBIOCR1001219750-751, 753–754. **Limon Province:** 1 male, Sector Cerro Cori, Fca. de E. Rojas, 150m, March 1993, E. Rojas, L-N-286000, 567500, INBIOCR-1001406312; 1 female, P.N. Tortuguero, Est. Cuatro Esquinas, 0m, September 1992, R. Delgado L-N 280000, 590500, INBIOCR1000840248. **Puntarenas Province:** 20 females, 8 males with cocoons, Península de Osa, Rancho Quemado, 200m, August 1991, F. Quesada, L-S-292500, 511000, INBIOCR1001329113-140. Paratypes deposited in INBio, UCR, RMSEL.

Distribution.—Known only from the type localities in Costa Rica.

Biology.—*Meteorus papiliovorus* is a gregarious koinobiont endoparasitoid of papilionid larvae including *Papilio anchisiades idaeus* Fabricius on *Citrus* and *Parides sesostris zestos* (Gray) on *Aristolochia tonduzii*. A second *Parides* species may also be utilized. At the Pitilla research site NMZ found two distinct larval forms, A and B, of the host caterpillars (Figs. 3, 6–7) feeding on *Aristolochia tonduzii* (one individual of larval form B was found on an unidentified host plant). These two larval forms are distinguished by the presence of lateral white tubercles immediately posterior to the head (Fig. 6), or their absence (Fig. 7), on the penultimate instar. The presence of these white tubercles on the ultimate instar of larval form A, along with distinct maroon-colored circular markings on the dorsal surface (Fig. 3) further serves to separate the two larval forms. Form A was reared to the adult, and identified as *Parides sesostris zestos* using DeVries (1987). Form B was not reared to adult because all the larvae collected were parasitized.

When utilizing *Parides sesostris zestos*, *M.*

papiliovorus emerged from both the penultimate and ultimate instars. The adult wasps emerged from their cocoons 10–12 days later.

DeVries (1987) indicated that larvae of *Papilio anchisiades idaeus* are parasitized by braconid wasps, but gave no more detail. Also, there are unconfirmed reports of this parasitoid emerging commonly from *Papilio* larvae collected in *Citrus* groves near San Jose.

Comments.—The distinctive color pattern of this species (Fig. 8), with bright yellow body, black dorsally, and black tinted wings, and the strongly narrowed second submarginal cell (Fig. 10) are fully diagnostic. In specimens where forewing veins *r* and 3RSa are about equal in length, the second submarginal cell remains strongly narrowed. Another species that has been examined, but is still undescribed, shares with *M. papiliovorus* dark tinted wings and a strongly narrowed second submarginal cell. However, it has a shorter, curved ovipositor (ovipositor about equal to length of first tergite), moderately twisted mandibles, and was reared from *Manduca sexta* (D.H. Janzen voucher specimen #95-SRNP-7538, and #95-SRNP-7539). *M. papiliovorus* keys to couplet 20 in Muesebeck's (1923) key.

Etymology.—Derived from the Latin *papilio* for butterfly, and *voratus* for devourer, in reference to the feeding habits of this species.

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Figure credits: Figs. 1–2, 4, S. R. Shaw; Figs. 5–7, R. G. Thorn; Fig. 3, 8–10, N. Zitani.

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